

First report of *Hippeastrum puniceum* (Lam.) Kuntze (Amaryllidaceae) from the state of Maranhão, Brazil, and expansion of the geographical distribution of *Alophia drummondii* (Graham) R.Foster (Iridaceae) and *Rapatea paludosa* Aubl. (Rapateaceae)

Miguel Sena de Oliveira^{1*}, Wagner Ribeiro da Silva Junior², Eduardo Oliveira Silva³, Raysa Valéria Carvalho Saraiva⁴, Alessandro Wagner Coelho Ferreira⁵

1 Post-graduate Program in Biological Sciences – Tropical Botany, Universidade Federal Rural da Amazônia/Museu Paraense Emílio Goeldi, Belém, PA, Brazil • MSO: miguelsena2010@hotmail.com  <https://orcid.org/0000-0001-8931-4978>

2 Post-graduate Program in Biodiversidade Ambiente e Saúde, Universidade Estadual do Maranhão, Caxias, MA, Brazil • WRSJ: wagner.botany@gmail.com  <https://orcid.org/0000-0002-5564-9224>

3 Coordination of Natural Sciences, Universidade Federal do Maranhão, Codó, MA, Brazil • EOS: eoliveira12@yahoo.com.br  <https://orcid.org/0000-0002-8899-2774>

4 Center for Human, Natural, Health and Technology Sciences, Universidade Federal do Maranhão, Pinheiro, MA, Brazil • RVCS: raysa.valeria@ufma.br  <https://orcid.org/0000-0002-0893-7338>

5 Department of Biology, Universidade Federal do Maranhão, São Luís, MA, Brazil • AWCF: alessandrowcf@yahoo.com.br  <https://orcid.org/0000-0002-0961-5189>

* Corresponding author

Abstract

We report the first record of *Hippeastrum puniceum* (Lam.) Kuntze in Maranhão and expand the known geographical distributions of *Alophia drummondii* (Graham) R. Foster and *Rapatea paludosa* Aubl. in that state. *Alophia drummondii* and *Hippeastrum puniceum* were collected in Cerrado fragments in the municipality of Caxias and *Rapatea paludosa* in a swamp-forest gallery in a transition area between the Amazon region and the Cerrado in the municipality of Morros. Ecological and taxonomic information is included, as well as morphological descriptions, identification keys to species, distribution maps, photographs, and preliminary conservation statuses of these species in Brazil.

Keywords

Amazon, Cerrado, taxonomy

Academic editor: Ana Carolina Devides Castello | Received 26 October 2021 | Accepted 11 March 2022 | Published 1 April 2022

Citation: Oliveira MS, Silva Junior WR, Silva EO, Saraiva RVC, Ferreira AWC (2022) First report of *Hippeastrum puniceum* (Lam.) Kuntze (Amaryllidaceae) from the state of Maranhão, Brazil, and expansion of the geographical distribution of *Alophia drummondii* (Graham) R.Foster (Iridaceae) and *Rapatea paludosa* Aubl. (Rapateaceae). Check List 18 (2): 323–330. <https://doi.org/10.15560/18.2.323>

Introduction

Brazil stands out by having the most species-rich flora on the planet, with over 35,000 species, of which 18,790 are endemic. However, several regions and states, such as

Maranhão, are still undersampled (Flora do Brasil 2020–2022). Taxonomic and floristic studies provide the essential, important information on the origin and geographic

distribution of plant species (Rossatto et al. 2008).

The state of Maranhão is located at the convergence between the Amazon, Cerrado, and Caatinga domains and, therefore, has varied plant formations and a diverse flora (Muniz 2006; Dias et al. 2009). However, recently published new records (Ferreira et al. 2017, 2018, 2019a, 2019b; Guarçoni et al. 2018; Rodrigues et al. 2019; Guarçoni et al. 2020a, 2020b; Salazar-Ferreira et al. 2020; Silva et al. 2020; Silva Junior et al. 2020a; Almeida et al. 2021; Oliveira et al. 2021; Ferreira et al. 2022) and new species (Scatigna et al. 2019; Guarçoni et al. 2020b; Santos et al. 2020) suggest that the flora of Maranhão is still poorly known.

We provide the first record of *Hippeastrum puniceum* (Lam.) Kuntze and expand the known geographic distributions of *Alophia drummondii* (Graham) R. Foster (Iridaceae) and *Rapatea paludosa* Aubl. (Rapateaceae) in the state of Maranhão, northeastern Brazil (Fig. 1). We present identification keys to species of *Hippeastrum* Herb., *Alophia* Herb., and *Rapatea* Aubl. in Maranhão, morphological descriptions, photographs, and georeferenced new records of the three species. We also provide preliminary conservation statuses of these species in Brazil.

Methods

Located in the Northeast Region of Brazil, the state of Maranhão has 217 municipalities and occupies an area

of 331,983 km². The vegetation has ecotonal characteristics due to its position between the Amazon (Northern Region of Brazil), Cerrado (Midwest Region) and Caatinga (Northeast Region) domains (Muniz 2006). The climate is of the “Am” type according to Köppen climate classification system (Alvares et al. 2013), with an average annual temperature of up to 27 °C and an average annual rainfall of 800–2,800 mm (Martins and Oliveira 2011). There is a dry season (June to December), and a rainy season from January and March (IMESC 2008).

The specimens collected were herborized according to the botanical treatment proposed by Fidalgo and Bononi (1989) and the botanical classification system used was the APG IV (2016). The species were identified with the specialist literature (Dutilh 2005; Alves-Araújo et al. 2009; Cândido et al. 2014) and by comparison with material already identified and available online in herbaria (CEN, HUTO, MO, NY, P, RB, UB, UNB; acronyms according to Thiers 2020). The geographic distribution of the species has been reported by Govaerts (2021) and is available online in SpeciesLink (2021), Tropicos (2021), and Flora do Brasil 2020 (2022) databases. The exsiccates were deposited in the Rosa Mochel herbarium (SLUI) of the Universidade Estadual do Maranhão, São Luís, Maranhão.

The maps were produced with QGIS v. 2.18.12 using the SIRGAS 2000 system. The software Adobe

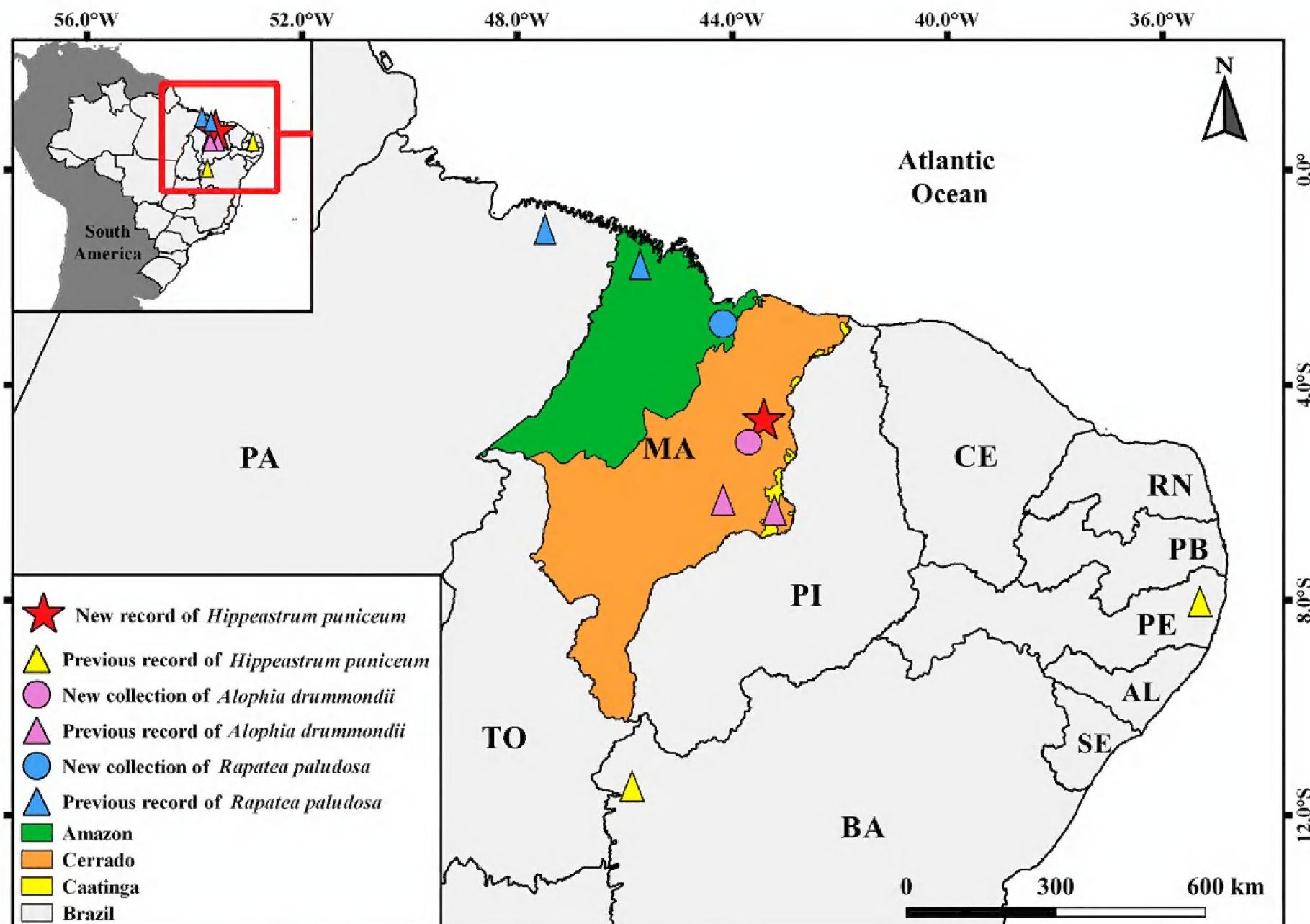


Figure 1. Collection sites and close by previous records *Hippeastrum puniceum* (Lam.) Kuntze, *Alophia drummondii* (Graham) R. Foster, and *Rapatea paludosa* Aubl. in Maranhão, Brazil.

Photoshop CS5 v. 12.0 was used to assemble and edit the figures.

For determining the preliminary conservation statuses of the species, the extent of occurrence (EOO) and the area of occupancy (AOO) of each species were calculated using the Geospatial Conservation Assessment Tool (GeoCAT; <http://geocat.kew.org>). AOO was based on a 2×2 -km cell (Bachman et al. 2011). For the evaluation, data from our collected specimens and 248 occurrences (with coordinates) obtained from SpeciesLink (2021) were used. We assessed the conservation status of each species using the criteria of the International Union for Conservation of Nature (IUCN 2012).

Results

Hippeastrum puniceum (Lam.) Kuntze

Figure 2

New records. Brazil – Maranhão • Municipality of Caxias, Baixão do Albuquerque, 2nd district of Caxias; 04°40'03"S, 043°24'48"W; 27.X.2020; M.S. de Oliveira & A.W.C. Ferreira 170 leg. (SLUI 5947); M.S. de Oliveira & A.W.C. Ferreira 171 leg. (SLUI 5948) M.S. de Oliveira & A.W.C. Ferreira 172 leg. (SLUI 5949); M.S. de Oliveira & A.W.C. Ferreira 173 leg. (SLUI 5950); M.S. de Oliveira & A.W.C. Ferreira 174 leg. (SLUI 5951); M.S. de Oliveira & A.W.C. Ferreira 175 leg. (SLUI 5952).

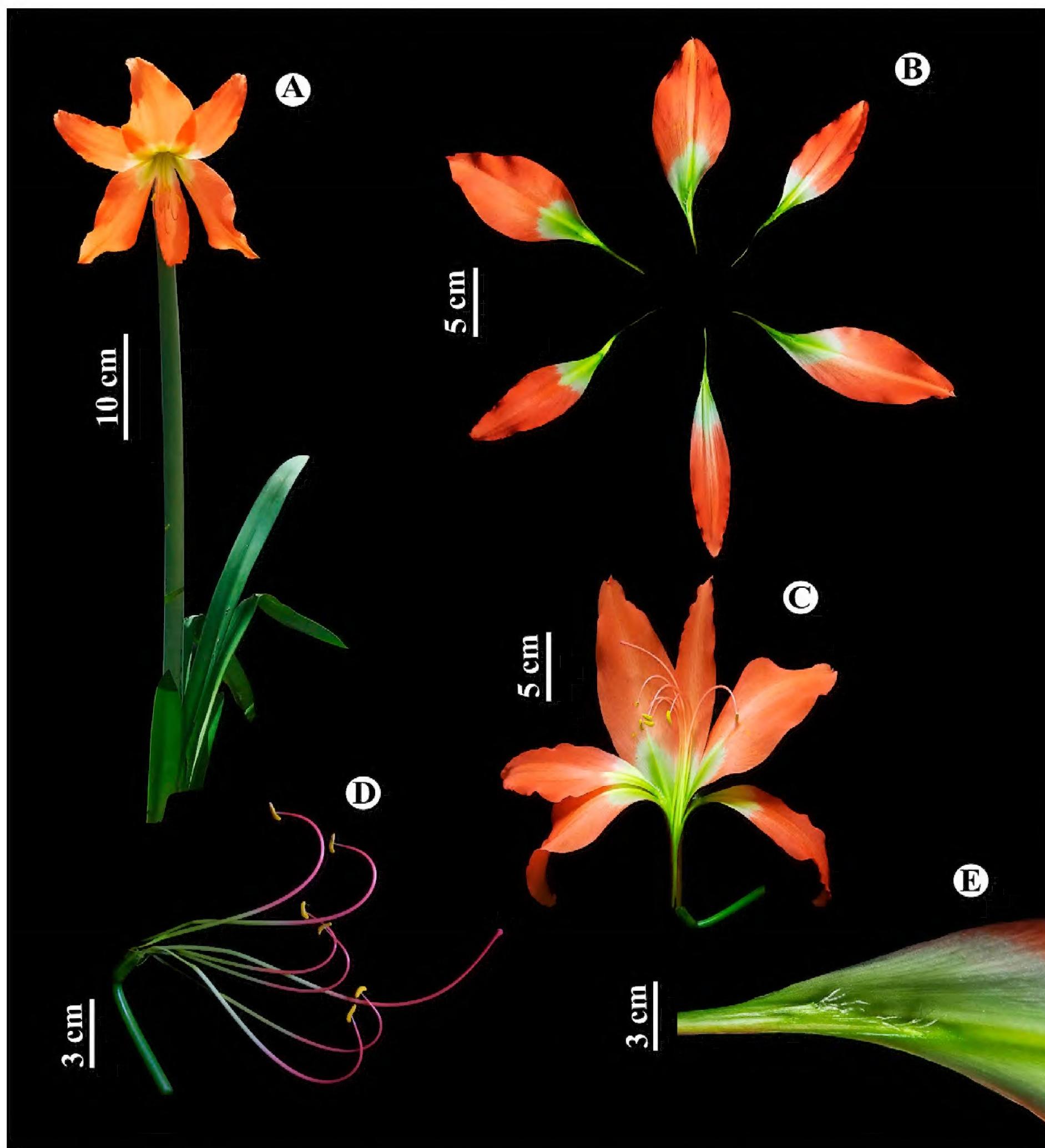


Figure 2. *Hippeastrum puniceum* (Lam.) Kuntze. **A.** Inflorescence and leaves. **B.** Dissected tepals. **C.** Internal view of the flower. **D.** Flower with the perigonium removed, showing the stamens and pistil. **E.** Fimbriae at the base of the tepals.

Identification. Perennial herb, 64–77 cm height during flowering. **Bulb** light brown, subterranean, orbicular, $3.4\text{--}4.5 \times 5.3\text{--}7.1$ cm; bulb neck 3.0–4.9 cm long. **Leaves** annual, green, ensiform, erect, with canalicular base, margin entire, apex acute, $32.1\text{--}53.2 \times 1.7\text{--}3.1$ cm. **Inflorescence** 2 or 3 flora, umbelliform, cylindric, hollow, $64.1\text{--}71.2 \times 1.6\text{--}1.9$ cm; bracts green, spathaceous, free, with acute apex, $4.1\text{--}7.1 \times 0.7\text{--}1.0$ cm. **Flowers** orange, reflexed, pedicels; pedicel green, cylindrical, 3.4–6.1 cm long; Perigone declined, campanulate, 11.5–13.7 cm long; hypanthium tube orange, 2.1–3.1 cm long; Tepals 6, orange to reddish, reflexed internally yellowish and forming a ring around the middle region of the tepals; external superior tepal $12.4\text{--}13.5 \times 3.7\text{--}4.5$ cm, external lateral tepal $12.6\text{--}13.2 \times 2.9\text{--}4.0$ cm, lower inner tepal $12.4\text{--}13.1 \times 2.1\text{--}2.4$ cm, inner lateral tepal $12.1\text{--}13.4 \times 2.8\text{--}4.2$ cm; stamens tridynamos, fillets green from the base to the median region and red in the apical portion, 5.6–10.2 cm long, anthers yellow, 5–9.1 cm long; lower ovary, trilocular, 8–10.1 mm long; stigma capitate, 3-lobed, red; stylet green from the base to the median region and red in the apical portion, 10–10.5 cm long; **Fruit** not seen.

Identification key to *Hippeastrum* species in Maranhão

- 1 Inflorescence 2 flora, greenish flowers, presence of a greenish ring in the inner medial region of the tepals, homodynamo stamens, anthers cream
..... *Hippeastrum elegans* (Spreng.) H.E.Moore
- 1' Inflorescence >2 flora, flowers red or orange, ring in the inner medial region of the tepals present or absent, isodynamic stamens or tridynamo, anthers cream with vinaceous or yellow bands 2
- 2 Inflorescence 2–7 flora, flowers red, ring in the inner medial region of the tepals absent, stamens isodynamic, anthers cream with vinaceous bands
..... *Hippeastrum stylosum* Herb.
- 2' Inflorescence 2 or 3 flora, flowers orange, presence of yellowish ring in the inner medial region of the tepals, stamens tridynamo, anthers yellow
..... *Hippeastrum puniceum* (Lam.) Kuntze

Alophia drummondii (Graham) R.C. Foster

Figure 3A–C

New records. Brazil – Maranhão • Municipality of Caxias, Baixão do Albuquerque, 2nd district of Caxias; 04°40'02"S, 043°24'18"W; 2.XII.2018; M.S. de Oliveira & A.W.C. Ferreira 88 leg. (SLUI 5953) • Municipality of Caxias, Área Municipal de Proteção Ambiental de Inhamum; 04°53'26"S, 043°25'44"W; 28.IV.2018; M.S. Oliveira s/n leg. (SLUI 5954).

Identification. Herbs, 55–65 cm high. **Bulbs** ca. $1.3\text{--}4.2 \times 0.8\text{--}2.2$ cm. **Leaves** 1–3 per plant. $22\text{--}45 \times 0.2\text{--}1.2$ cm. linear to narrow-lanceolate. membranaceous **Scape** ca. 41 cm long. Bracts, 1–3, 3-branched, linear; first bract $8\text{--}46 \times 0.4\text{--}1.5$ cm, other bracts ca. $2.7\text{--}5.5 \times 0.3\text{--}0.5$ cm, separated by internodes. **Ripidia** 1–3, lax; peduncle

1.7–10.2 cm long; spaths $1.3\text{--}6 \times 0.4\text{--}1.3$ cm. **Flowers** purple; outer tepals obovate, $1.3\text{--}2.4 \times 0.8\text{--}1.6$ cm, with rounded or truncate apex and median-basal region yellowish with brownish-brown grooves; internal tepals $1.2\text{--}1.6 \times 0.5\text{--}0.7$ cm, involuted, with rounded apex and yellowish base; filaments purple, ca. 0.4 cm long, attached to the base; anthers purple, 0.4–0.6 cm long; ovary 4.5 cm long; styles purple, ca. 0.7 cm long; stigmas bifid. **Fruit** capsule $4\text{--}3.5 \times 0.7\text{--}1.2$ cm, oblong; seeds ca. 0.3×0.2 cm.

Identification key to *Alophia* species in Brazil

- 1 Leaves teret or subteret; long terminal bract above ripidia *Alophia medusae* (Baker) Goldblatt
- 1' Leaves of ensiform or linear limbus, plicated; terminal bract above ripidia absent
..... *Alophia drummondii* (Graham) R.Foster.

Rapatea paludosa Aubl.

Figure 3D, E

New record. Brazil. Maranhão • Morros, Rio Pacas; 02°53'43"S, 044°04'9"W; 28.I.2021; A.W.C. Ferreira 1557 leg. (SLUI 5955).

Identification. Herb 70–100 cm long. **Leaves** discolored, symmetrical, with mucilage at base; petiole absent, with sheaths 16.0–25.5 cm long \times 1.2–2.4 cm wide; leaf blade 84–137 cm long \times 6–9.5 cm wide, wide-lanceolate, glabrous, surfaces with inconspicuous roughness, prominent central vein on both sides, prominent secondary veins on the abaxial surface, apex acute, base attenuate. **Inflorescence** capituliform, terminal, axis flattened to convex, spikelets ca. 50–70; scape 15–40 \times 0.6–1.9 cm, flattened, sparsely pubescent, sulcate; bracts two, spathiform, at apex of scape, $10.5\text{--}23 \times 4.7\text{--}6.5$ cm, lanceolate to wide-lanceolate, distinct from the central axis of the inflorescence, erect, persistent, apex acute, base cordate or subcordate; spikelet pedicellate, with a series of terminal bracteoles and a single flower; pedicel 1.0–1.8 cm long, sparsely pubescent; bracteoles 11–13 per spikelet, heterogeneous; proximal bracteoles 0.64–1.1 cm long; distal bracteoles 1.2–1.45 cm long, oblong to elliptic-lanceolate, papyraceous, apex brown and long-acuminate or aristate. **Flower** pedicellate; pedicels 1.1–2.3 cm long; **sepals** 0.75–1.5 cm long, briefly connate at the base forming a hyaline-membranous tube, lanceolate lobes, navicular, papyraceous; **petals** $1.4\text{--}1.6 \times 0.4$ cm, yellow, connate forming a hyaline-membranous tube; trilobed, lobes obovate; filaments ca. 1.3 cm long, tomentose; stamens 6; **anthers** 0.4–0.75 cm long, yellow, lanceolate, 4-locular, sulcate, with apical appendages to 0.15 cm long, brown; **ovaries** 0.3–0.5 cm long, rounded, apocarpous, carpels 3, unilocular; styles ca. 1.2 mm long, central, apically recurved, bases whitish; stigma ca. 0.5 mm long, simple, swollen, brown. **Capsules** ca. $0.5\text{--}0.65 \times 0.28\text{--}0.35$ cm, ovate, obovate to ellipsoid, yellowish. **Seed** 0.27–0.33 mm long, ellipsoid to oblong, brown when ripe, longitudinally striate.



Figure 3. A–C. *Alophia drummondii*: (A) inflorescence and flower; (B) fruits; (C) flower in front view. D, E. *Rapatea paludosa*: (D) flower in front view; (E) inflorescence in lateral view.

Identification key to *Rapatea* species in Maranhão

- 1 Leaf blades lanceolate and base asymmetrically attenuated; inflorescence capituliform *Rapatea paludosa* Aubl.
- 1' Leaf blades narrowly lanceolate and base symmetrical attenuated; inflorescence glomerulate *Rapatea pycnocephala* Seub.

Discussion

Our findings of *Hippeastrum puniceum* (Fig. 2) increase the known geographic distribution of this species. The nearest previously known occurrences nearest collection points (Reflora 2021; SpeciesLink 2021) are approximately 802 km south (Formosa do Rio Preto, Bahia, Brazil), 1,079 km west (Serra do Cachimbo, Pará, Brazil), and 996 km east (São Lourenço da Mata, Pernambuco, Brazil) from where we collected this species. Additionally, our new findings are the first of this species in Maranhão, expanding the geographic distribution of the species and the genus *Hippeastrum* in the Northeast Region of Brazil. This demonstrates the importance of more collection effort for the documentation of the flora of Maranhão.

Hippeastrum puniceum is widely distributed in the Neotropics (Govaerts et al. 2021) and occurs in several Brazilian states. In Brazil, it is distributed in all phytogeographic domains Amazon, Atlantic Forest, Caatinga, Cerrado, Pampa, and Pantanal and confirmed from the states of Amazonas, Amapá, Bahia, Espírito Santo, Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Pernambuco, Paraná, Rio de Janeiro, Rio Grande do Sul, São Paulo, and Santa Catarina, as well as the Distrito Federal according to BFG (2015, 2018), Dutilh et al. (2020), and Flora do Brasil 2020 (2022).

Hippeastrum puniceum occurs in various vegetation formations and environments, such as wet lowlands, plateaus, fields, Cerrado, abandoned cultivation areas, sandbanks, and rocks (Dutilh 2005; Candido et al. 2014). We found this species at the beginning of the rainy season (November and December) on sandy soil in a Cerrado fragment. There was a small population of approximately six flowering individuals, with the presence of leaves and flower buds at different stages of development, which open consecutively.

Using the 249 occurrences of *H. puniceum* in Brazil (SpeciesLink 2021), including our new record, the species has an EOO of 7,154,200 km² and an AOO of

684 km² (Fig. 4). Therefore, according to IUCN criteria (IUCN 2012), *H. puniceum* is preliminarily assessed as Least Concern.

In Brazil, *H. puniceum* is popularly known as açucena, açucena-laranja, amarilis, cebola-berrante, lírio, lírio-vermelho (Neto and Amaral 2010; Candido et al. 2014; Ribeiro and Boscolo 2018). This species exhibits seasonal leaf loss. It is easy to grow and has showy flowers that are variable in color and so it is occasionally cultivated in domestic gardens in several Brazilian states (Dutilh 2005; Alves-Araújo et al. 2009; Candido et al. 2014). In some countries, it is cultivated for medicinal purposes (Hanelt 2001). In Brazil, only bulbs have been reported to be used in traditional medicine, even though the safety and efficacy of their use have not yet been scientifically proven (Lorenzi and Matos 2008).

We expand the geographic distribution of *A. drummondii* (Fig. 3A–C) north by 194 km from Mirador State Park, Geraldina base, Maranhão and 209 km from Barão de Grajaú, Maranhão (SpeciesLink 2021; Flora do Brasil 2020 2022).

Alophia drummondii occurs from the United States of America to South America (Goldblatt and Manning 2008). In Brazil it is known only from Alagoas, Ceará, Paraíba, Pernambuco, Maranhão, Piauí, Rio Grande do Norte, and Bahia, in the northeastern region, where it occurs in areas of Cerrado and Caatinga vegetation (Oliveira et al. 2016; Melo et al. 2018; Eggers and Chauveau 2020; Flora do Brasil 2020 2022). The

conservation status of this species has not yet been evaluated (Eggers and Chauveau 2020; IUCN 2021).

In Maranhão, *A. drummondii* is known to occur together with *A. medusae* (Baker) Goldblatt, which is distinguished by the plicated, ensiform or linear leaf blades and the absence of a terminal bract projecting above the ripidia. Integrative taxonomy studies, including samples from throughout the entire distribution of the species, are needed to better understand this taxon (Eggers and Chauveau 2020).

We expand the geographic distribution of *Rapatea paludosa* (Fig. 3D, E) east by 221 km from Fazenda Sete Irmão, Cândido Mendes, Maranhão, and 447 km from Maracaná, Pará (SpeciesLink 2021; Flora do Brasil 2022).

Rapatea paludosa occurs in Brazil, French Guiana, Guyana, Panama, Suriname, and Venezuela (Tropicos 2020). In Brazil, specimens have been reported in the Amazon Forest and Atlantic Forest of Acre, Amapá, Amazonas, Pará, Rondônia, Tocantins, Mato Grosso, Bahia (Praia et al. 2016; Flora do Brasil 2022), and Maranhão (Ferreira et al. 2019c). The conservation status of this species has not yet been evaluated (IUCN 2021).

According to Ferreira et al. (2019c), in Maranhão (Sete Irmãos Farm, Cândido Mendes), *R. paludosa* occurs in small populations in fragmented areas that are constantly altered by human activities. The Maranhense Amazon is the most threatened in Maranhão and about 76% of its land area has been deforested and the remaining 24% has some level of disturbance (Celentano et al.

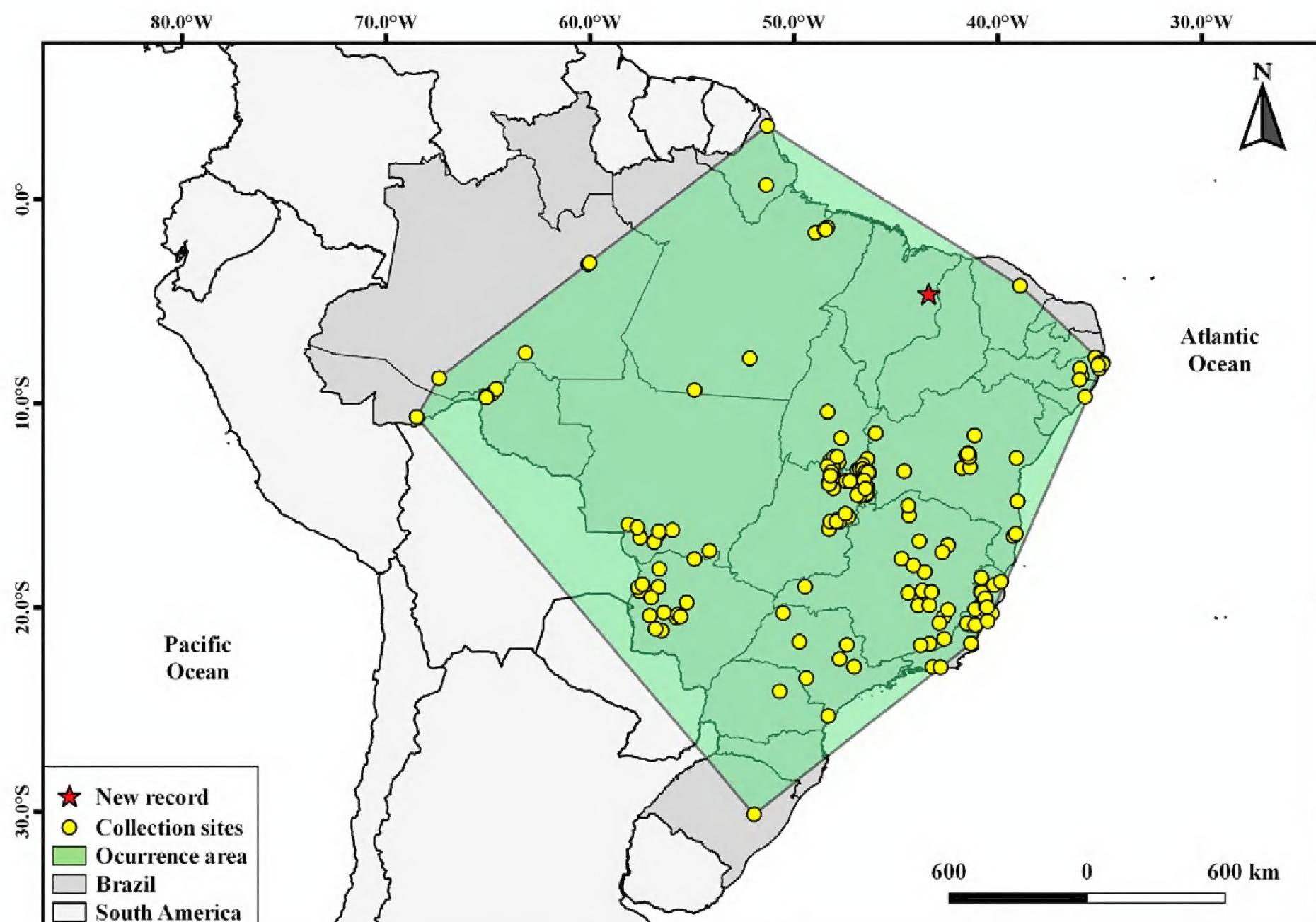


Figure 4. Area of occurrence of *Hippeastrum puniceum* in Brazil.

2017, 2018; Silva Junior et al. 2020b). Therefore, *R. paludosa* has likely been affected by deforestation and may be threatened, at least in Maranhão. The population that we found in Morros, which is within in a transitional area with the Cerrado Maranhense, is larger than the Cândido Mendes population observed by Ferreira et al. (2019c). However, the Morros population also is under threat from deforestation and trampling caused by pigs and chickens from nearby rural properties.

Acknowledgements

We thank Raimundo Nonato Ferreira de Oliveira Filho and family for authorizing entry into his property and conducting field expeditions. FAPESPA/MPEG/FADESP for granting the scholarship to one of us (M.S. Oliveira). A.W.C. Ferreira thanks FAPEMA (Edital Universal 01312-2019). We also thank the subject editor and the anonymous reviewers.

Authors' Contributions

Conceptualization: MO. Formal analysis: MO, AF. Investigation: MO, AF, ES. Methodology: MO, AF, WSJ. Writing – original draft: MO, AF, ES, RS. Writing – review and editing: MO, AF, ES, RS, WSJ.

References

- Almeida RBP, Antar GM, Ferreira AWC, Silva Junior WR, Oliveira MS, Saraiva RVC (2021) Lectotypification and notes on the distribution of the giant herb *Phenakospermum guyannense* (Rich.) Miq. (Strelitziaceae). *Phytotaxa* 491 (3): 239–248. <https://doi.org/10.11646/phytotaxa.481.3.4>
- Alvares CA, Stape JL, Sentelhas PC, Gonçalves JLM, Sparovek G (2013) Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22 (6): 711–728. <https://doi.org/10.1127/0941-2948/2013/0507>
- Alves-Araújo A, Dutilh JHA, Alves M (2009) Amaryllidaceae s.s. e Alliaceae s.s. no Nordeste brasileiro. *Rodriguésia* 60 (2): 311–331. <https://doi.org/10.1590/2175-7860200960206>
- APG IV (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 105–121. <https://doi.org/10.1111/boj.12385>
- Bachman S, Moat J, Hill AW, De La Torre J, Scott B (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117–126. <https://doi.org/10.3897/zookeys.150.2109>
- BFG (The Brazil Flora Group) (2015) Growing knowledge: an overview of seed plant diversity in Brazil. *Rodriguésia* 66: 1085–1113. <https://doi.org/10.1590/21757860201566411>
- BFG (The Brazil Flora Group) (2018) Brazilian Flora 2020: innovation and collaboration to meet Target 1 of the Global Strategy for Plant Conservation (GSPC). *Rodriguésia* 69: 1513–1527. <https://doi.org/10.1590/2175-7860201869402>
- Candido RS, Gonçalves-Esteves V, Lopes RC (2014) *Hippeastrum* (Amaryllidoideae – Amaryllidaceae) das Restingas do estado do Rio de Janeiro: Flora e conservação. *Pesquisas, Botânica* 65: 49–65.
- Caxias(2011) Decreto Municipal n.º 2.943/2013. Plano municipal de saneamento básico de Caxias (MA). <http://rigeo.cprm.gov.br/xmlui/bitstream/handle/doc/15431/relcaxias.pdf?sequence=1>. Accessed on: 2019-4-23.
- Celentano D, Rousseau GX, Muniz FH, Varga ID, Martinez C, Carneiro MS, Miranda MCV, Barros MNR, Freitas L, Narvaez IS, Adami M, Gomes AR, Rodrigues JC, Martins MB (2017) Towards zero deforestation and forest restoration in the Amazon region of Maranhão state, Brazil. *Land Use Policy* 68: 692–698. <https://doi.org/10.1016/j.landusepol.2017.07.041>
- Celentano D, Miranda MVC, Mendonça EN, Rousseau GX, Muniz FH, Loch VC, Varga ID, Freitas L, Araújo P, Narvaez IS, Adami MG, Alessandra R, Rodrigues JC, Kahwage C, Pinheiro M, Martins MB (2018) Desmatamento, degradação e violência no “Mosaico Gurupi”—a região mais ameaçada da Amazônia. *Estudos Avançados* 32: 315–339. <https://doi.org/10.5935/0103-4014.20180021>
- Chase MW, Reveal JL, Fay MF (2009) A subfamilial classification for the expanded asparagalean families Amaryllidaceae, Asparagaceae and Xanthorrhoeaceae. *Botanical Journal of the Linnean Society* 161: 132–136.
- Dias PAD, Santos CLC, Rodrigues FS, Rosa LC, Lobato KS, Rebêlo JMM (2009) Espécies de moscas ectoparasitas (Diptera, Hippoboscoidea) de morcegos (Mammalia, Chiroptera) no estado do Maranhão. *Revista Brasileira Entomologia* 53: 128–133.
- Dutilh JHA (2005) Amaryllidaceae. In: Wanderley MGL, Shepherd GJ, Melhem TSA, Martins SE, Kirizawa M, Giulietti AM (Eds.) *Flora fanerogâmica do estado de São Paulo*. vol. 4. FAPESP and RiMa, São Paulo, Brazil, 244–255.
- Dutilh JHA, Campos-Rocha A, Sassone AB, Oliveira RS, Giussani LM, Meerow AW, Semir J, Streher NS, Garcia N (2020) *Hippeastrum* in Flora do Brasil 2020. Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB4366>. Accessed on: 2022-1-21.
- Eggers L, Chauveau O (2020) *Alophia* in Flora do Brasil 2020. Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB135929>. Accessed on: 2021-03-23.
- Ferreira AWC, Oliveira MS, Silva EO, Campos DS, Pansarin ER, Guarçoni EAE (2017) *Vanilla bahiana* Hoehne and *Vanilla pompona* Schiede (Orchidaceae, Vanilloideae): two new records from Maranhão state, Brazil. *Check List* 13: 1131–1137. <https://doi.org/10.15560/13.6.1131>
- Ferreira AWC, Calió MF, Silva Junior WR, Silva MJC, Oliveira MS, Silva EO, Guarçoni EAE, Carvalho AKC, Figueiredo N (2018) First record of *Voyria caerulea* Aubl. (Gentianaceae), a mycoheterotrophic plant, in Maranhão state, northeastern Brazil. *Check List* 14: 833–837. <https://doi.org/10.15560/14.5.833>
- Ferreira AWC, Oliveira MS, Silva Junior WR, Andrade IM, Coelho MAN, Oliveira HC, Mayo SJ (2019a) New occurrences of small aquatic duckweeds (Araceae, Lemnoideae) in Maranhão state, northeastern Brazil. *Check List* 15: 1153–1160. <https://doi.org/10.15560/15.6.1153>
- Ferreira AWC, Oliveira MS, Engels ME, Pessoa E (2019b) Found in Brazil again! Expanding the distribution of *Maxillaria aureoglobula* Christenson (Orchidaceae, Maxillariinae) and a key to the species of *Maxillaria* sect. *Rufescens* Christenson from Brazil. *Check List* 15: 1107–1112. <https://doi.org/10.15560/15.6.1107>
- Ferreira AWC, Lima GP, Silva MJC, Almeida Jr, EB (2019c) Geographic range extension of *Rapatea paludosa* Aubl. (Rapateaceae) to Maranhão state, northeastern Brazil. *Check List* 15: 9–21. <https://doi.org/10.15560/15.5.911>
- Ferreira A WC, Zanandrea I, Santos J, Pereira WAJ, Oliveira MS (2022) Expansion of the geographic distribution of a Brazilian endemic, *Encyclia gonzalezii* L.C. Menezes (Orchidaceae, Epidendroideae), to the Cerrado of Maranhão and the Northeast Region of Brazil. *Check List* 18: 139–145. <https://doi.org/10.15560/18.1.139>
- Fidalgo O, Bononi VLR (1989) Técnicas de coleta, preservação de material botânico. Série Documentos. Instituto de Botânica, São Paulo, Brazil, 62 pp.
- Flora do Brasil 2020 (2022) Flora do Brasil 2020. <http://floradobrasil.jbrj.gov.br/>. Instituto de Pesquisas, Jardim Botânico do Rio de Janeiro. Accessed on: 2022-01-20.
- Goldblatt P, Manning JC (2008) The Iris Family: natural history &

- classification. Timber Press, Portland. 290 pp.
- Govaerts R (2021) <https://wcsp.science.kew.org>. Royal Botanic Gardens, Kew. Accessed on: 2021-01-03.
- Guarçoni EAE, Costa AF, Silva EO, Ferreira AWC, Oliveira MS (2018) New records of *Tillandsia* L. (Bromeliaceae, Tillandsioideae) for Maranhão state, Brazil. Check List 14: 951–959. <https://doi.org/10.15560/14.6.951>
- Guarçoni EAE, Sousa JDS, Ferreira AWC, Silva Junior WR, Oliveira MS, Silva EO (2020a) New occurrence records of Bromeliaceae for the state of Maranhão, northeastern Brazil. Check List 16 (6): 1575–1580. <https://doi.org/10.15560/16.6.1575>
- Guarçoni EAE, Saraiva RVC, Ferraz TM (2020b) *Dyckia maranhensis* (Bromeliaceae, Pitcairnioideae), a new species from the Cerrado of Maranhão, northeastern Brazil. Systematic Botany 45: 47–52. <https://doi.org/10.1600/036364420X15801369352289>
- Hanelt P (2001) Mansfeld's encyclopedia of agricultural and horticultural crops (except ornamentals). Springer, Heidelberg. 3648 pp.
- IBGE (2021) <https://cidades.ibge.gov.br/brasil/ma/sao-joao-do-soter/panorama>. Instituto brasileiro de geografia e estatística. Accessed on: 2021-01-03.
- IMESC (2008) <http://imesc.ma.gov.br/portal/Post/view/outras-publicacoes/38>. Instituto Maranhense de Estudos Socioeconômicos e Cartográficos, São Luís, Brazil. Accessed on: 2021-02-02.
- IUCN (2012) Red List categories and criteria: version 3.1., 2nd edition. International Union for the Conservation of Nature Species Survival Commission, Gland, Switzerland/Cambridge, UK. <http://www.iucnredlist.org/>. Accessed on: 2022-1-21.
- IUCN (2021) <https://www.iucnredlist.org/>. The IUCN Red List of Threatened Species. International Union for the Conservation of Nature, Gland, Switzerland/Cambridge, UK. Accessed on: 2021-01-29.
- Lorenzi H, Matos FJA (2008) Plantas medicinais no Brasil: nativas e exóticas. 2. ed. Nova Odessa: Instituto Plantarum, São Paulo, Brasil, 544p.
- Melo JIMD, Araújo AP, Monteiro FKDS, Gonçalves MGLM, Moura DC (2018) First record of *Alophia drummondii* (Iridaceae) for the Paraíba state and Caatinga vegetation, Brazilian northeastern. Biodiversity International Journal 2: 385–387. <https://doi.org/10.15406/bij.2018.02.00090>
- Muniz FH (2006) A vegetação da região de transição entre a Amazônia e o Nordeste: diversidade e estrutura. In: de Moura EG. (Ed.) Agro ambientes de transição entre o trópico úmido e o semiárido do Brasil: atributos, alterações e uso na produção familiar. 2 nd ed. Programa de Pós-graduação em Agroecologia/UEMA, São Luís, Brazil, 53–69.
- Neto GG, Amaral CN (2010) Aspectos etnobotânicos de quintais tradicionais dos moradores de Rosário Oeste, Mato Grosso, Brasil. Polibotânica 29: 191–212.
- Oliveira MS, Ferreira AWC, Oliveira HC, Pessoa E (2021) Orchids in the central region of eastern Maranhão, Brazil. Rodriguésia 72: e02582019: 1–15. <https://doi.org/10.1590/2175-7860202172057>
- Oliveira PN, Giulietti AM, Oliveira RP (2016) Flora da Bahia: Iridaceae. Sitientibus série Ciências Biológicas 16: 1–38. <https://doi.org/10.13102/scb1102>
- Praia TDS, Gil ADSB, Secco RDS (2016) Rapateaceae in the state of Pará, Brazil. Acta Botanica Brasilica 30 (4): 628–643. <https://doi.org/10.1590/0102-33062016abb0162>
- Rodrigues ML, Mota NFO, Viana PL, Koch AK, Secco RS (2019) Vascular flora of Lençóis Maranhenses National Park, Maranhão state, Brazil: checklist, floristic affinities and phytophysiognomies of restingas in the municipality of Barreirinhas. Acta Botanica Brasilica 33: 498–516.
- Ribeiro RSS, Boscolo OH (2018) Levantamento etnobotânico na praia do sossego, Niterói, RJ. Botânica Aplicada, Editora Atena, Brasil, 201 pp.
- Rossatto DR, Toniato MTZ, Durigan, G (2008). Flora fanerogâmica não-arbórea do cerrado na Estação Ecológica de Assis, Estado de São Paulo. Revista Brasileira de Botânica 31: 409–424.
- Santos D, Saraiva RVC, Ferraz TM, Arruda ECP, Buril MT (2020) A threatened new species of *Ipomoea* (Convolvulaceae) from the Brazilian Cerrado revealed by morpho-anatomical analysis. PhytoKeys 151: 93–106. <https://doi.org/10.3897/phytokeys.151.49833>
- Salazar-Ferreira M, Gonella PM, Guarçoni EAE (2020) New records of *Utricularia* (Lentibulariaceae) for the state of Maranhão, Brazil. Check List 16: 121–125. <https://doi.org/10.15560/16.1.121>
- Scatigna AV, Brandão CM, Colletta GD, Teles RM, Cavalcante KSB, Souza VC, Simões AO (2019) *Dizygostemon riparius* (Plantaginaceae, Gratiolae), a new species from Maranhão, northeastern Brazil. Willdenowia 49: 177–186. <https://doi.org/10.3372/wi.49.49206>
- Silva EO, Milward-de-Azevedo MA, Ferreira AWC, Sobral MEG (2020) Rediscovery and new records of *Passiflora auriculata* Kunth and *P. cisnana* Harms (Passifloraceae) in Brazil. Check List 16: 441–450. <https://doi.org/10.15560/16.2.441>
- Silva Junior CHL, Celentano D, Rousseau GX, Moura EG, Varga ID, Martinez C, Martins MB (2020) Amazon forest on the edge of collapse in the Maranhão State, Brazil. Land Use Policy 971: 04806. <https://doi.org/10.1016/j.landusepol.2020.104806>
- Silva Junior WR, Ferreira AWC, Ilkiu-Borges AL, Fernandes RS (2020a) Ferns and lycophytes of remnants in Amazônia Maranhense, Brazil. Biota Neotropica 20: 1–14. <https://doi.org/10.1590/1676-0611-bn-2020-0972>
- SpeciesLink (2021) <http://www.splink.org.br>. Accessed on: 2021-01-02.
- Thiers B (2021) <http://sweetgum.nybg.org/science/ih>. New York Botanical Garden's Virtual Herbarium. Accessed on: 2021-3-1.
- Tropicos. Missouri Botanical Garden. <http://www.tropicos.org/>. Access on: 2021-01-03.